

2 The Framework Transportation Identification Standard

2.1 Overview

A key piece in creating a national standard for geospatial data representing transportation networks is the development, implementation, and general acceptance of a transportation identification standard. The function of such a data standard is to enable database developers to transact updates and to exchange information by defining unique and relatively stable transportation reference points and segments that can be assigned permanent feature identifiers.

2.2 Relationships between the “Real World”, Cartography, and Networks, and the Framework Transportation Identification Standard

A useful transportation identification standard must successfully address several issues without causing unreasonable extra burden to either database developers or users. First, the standard must be useful in representing the physical or real-world domain of transportation features. Second, the standard must be useful in fulfilling the wide variety of mapping requirements of users. Third, the standard must support a large number of different network applications; for example: *address geo-coding, network pathfinding,*

420 *vehicle and incident location, and highway facility management.* Each of these
421 applications typically segments the network in different ways.

422 2.2.1 Physical (“Real-World”) Domain

423 Transportation features in the physical or real-world domain consist of tangible objects
424 such as *roads, bridges, railroad tracks, and intersections*. At a minimum, representations
425 of physical objects require information to enable someone to locate and recognize them in
426 the real world. Location information may be purely descriptive (e.g. “*the intersection of*
427 *the centerlines of 7th & D Streets, SW in Washington, DC*”), or the description may be
428 supplemented by measurements that can be repeated in the field (e.g., GPS coordinates).

429 This Standard supports the unambiguous identification of unique real-world features by
430 requiring some descriptive information and some quantitative positional information about
431 each feature, and by allowing its augmentation with other information when users make it
432 available.

433 2.2.2 Cartographic Domain

434 Cartographic objects are used to represent real world features on a map. In vector-based
435 GIS, real-world objects are typically displayed as *points* (or *symbols*), *lines*, or *polygons*.
436 Transportation networks are displayed using points and strings of line segments. While
437 there is no *a priori* requirement that cartographic points and strings must be topologically

connected, most GIS software build topology to facilitate spatial and network computations. However, the topology created by the GIS may not be the same as the topology specified in the transportation network (e.g., a node may be placed where two links cross but don't intersect).

Planar coordinates define the relative locations and shapes of cartographic objects on a two-dimensional plane. These coordinates are typically transformations of real world geographic coordinates (e.g., given a specified geodetic datum and projection). However, the relative accuracy of each plotted point is subject to various errors (e.g., physical location measurements, digitizing accuracy, and distortions caused by planar projections of three-dimensional distances). Consequently, there are differences in both the location and distance measurements between the real world and a map.

This Standard does not attempt to address these cartographic differences; nor does it attempt to reconcile the differences that exist among multiple cartographic representations of the same real-world features. However it does propose a standard method for specifying real-world features, so that users of different cartographic representations can more easily exchange updates to both geometric and tabular information.

2.2.3 Network Domain

Network objects consist of *links* and *nodes*, which together form the *network*; these objects are inherently topological. Transportation networks provide information on the

feasible paths between specified locations, and on decision points along those paths.

Origins and destinations are assumed to be specific as to location, but the location of a decision point need not exist in the physical world. A network does not require cartographic coordinates; rather, only a set of choices need be identified at each decision point (e.g., the decision point to drive or take transit can be made at any time or place prior to the decision to use transit).

Once a network has been created, other transportation application layers can be built upon it, including *identified routes*, *linear referencing methods*, and *linearly referenced points* and *linear events*. All of these application layers can ultimately be mapped back to the transportation reference points and segments through the specific network links and nodes on which these application layers were built. Geometric shape is not a required part of network *links*, *routes*, or *linear events*. Any of these may be constructed without coordinates. All that is required to construct the network layer (links and nodes) is the topological connections of the segments. Construction of routes and linear referencing methods is accomplished through an ordered listing of the links (or parts of links) that comprise each route. *EXAMPLE: Emergency service authorities may wish to define a “Road-Name” Route to support vehicle dispatch. They can do so by defining the “official” road name as an attribute associated with all or a part of each link. The ordered listing of all the links associated with each “official” road name will define the “Road-Name” Route.*

This Standard does not attempt to define topological relationships within any one or more networks, but does provide to the users of multiple networks a stable identifier for real-world features.

2.3 Components of the Transportation Identification Standard¹

2.3.1 Framework Transportation Segment Reference Point (FTRP) – *The specified location of a (required) endpoint of a Framework Transportation Segment (FTSeg), or an (optional) reference point offset along the length of the FTSeg, on a physical transportation system.*

2.3.1.1 The FTRP Table

An FTRP database record has a unique key consisting of fields 1, 2 and 3 (emboldened); values are required for all fields, except those designated “optional” or conditionally required. An FTRP record contains the following information²:

¹The abbreviations “FTRP” and “FTSeg” are used in this document as singular or plural nouns. When used singularly they are modified by “an” rather than “a” as a matter of convention.

²The NSDI Framework Transportation Identification Standard is being proposed as an “FGDC data content standard.” This proposal does not include standards for formatting or encoding the information described in this Table or in any other tables.

#	FTRP Table Field-Name	Description & Format/Domain
1	Authority-ID	Permanent and unique identifier of the organization which created this record. This ID may differ from the ID of the authority which created the original FTRP database entry or subsequent records. Format specified in Section 2.6
2	FW-Transportation-Segment-Reference-Point-ID	Permanent and unique identifier for the FTRP Format specified in Section 2.6
3	Date	Date of creation of the record Format YYYYMMDD
4	Location-Description	Unambiguous description of the FTRP that makes it field-recoverable Free text: 255 characters or less
5	FTRP-Feature-Type (<i>Optional</i>)	Format: Free text of ten characters or less; Domain declared by the authority
6	Latitude	Angular distance measured on a meridian north or south from the equator. (NAD83) Format: +/- DD.dddddd; 10 character Decimal degrees Range: +/-0 to 90.000000
7	Longitude	Angular distance between the plane of a meridian east or west from the plane of the prime meridian. (NAD83) Format: +/- DDD.dddddd; 11 character Decimal degrees Range: +/-0 to 180.000000

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8	Horizontal-Accuracy-Measurement-Method	<p>Three-character code which describes the derivation of the horizontal position, and which allows the user to assess the accuracy and precision of the FTRP latitude and longitude:</p> <p>100 = Derived from stationary GPS measurement, with no differential correction</p> <p>*1xx = Stationary GPS measurement -differentially corrected to "xx" meters; e.g., 105 = differential correction to 5 meter accuracy</p> <p>200 = Derived from mobile GPS measurement, without differential correction</p> <p>*2xx = Derived from mobile GPS measurement, differentially corrected to "xx" meters</p> <p>300 = Derived from non-GPS survey methods - accuracy unknown</p> <p>*3xx = Derived from non-GPS survey methods - accuracy certified to "xx" meters</p> <p>400 = Digitized from digital orthoimagery - Source scale unknown</p> <p>4xx = Digitized from digital orthoimagery - Source scale of image in 000's; e.g. 412 = 1:12,000 scale source digital orthophotos.</p> <p>5xx = Digitized from paper map sources larger than 1:100,000 scale - Source scale in 000's e.g. 524 = 1:24,000 scale topographic maps</p> <p>600 = Source scale 1:100,000 digital data - e.g., TIGER/Line or DLG</p> <p>6xx = Digitized from paper map sources smaller than 1:100,000 scale - Source scale in 100,000's e.g. 625 = 1:250,000 scale maps</p> <p>900 = Other</p> <p><i>* – "xx" should be "01" when accuracy is certified to 1 meter or less.</i></p>
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498	9	Horizontal-Accuracy (<i>Optional and Recommended</i>)	Maximum estimated error in horizontal location Format: MMM.mm; 6 characters, indicating “plus or minus” a number of meters
499	10	Elevation (<i>Optional and Recommended</i>)	Elevation above/below sea level Format: +/- MMM.mm; 7 character decimal meters, indicating “plus or minus” a number of meters
500	11	Vertical-Accuracy-Measurement-Method (<i>Required if Elevation is not “blank”</i>)	Three-character code which describes the derivation of the elevation, and which allows the user to assess the accuracy and precision of the FTRP elevation: 100 = Derived from stationary GPS measurement, with no differential correction *1xx = Stationary GPS measurement -differentially corrected to “xx” meters; e.g., 105 = differential correction to 5 meter accuracy 200 = Derived from mobile GPS measurement, without differential correction *2xx = Derived from mobile GPS measurement, differentially corrected to “xx” meters 300 = Derived from non-GPS survey methods, accuracy unknown *3xx = Derived from non-GPS survey methods, accuracy certified to “xx” meters 800 = Derived from a Digital Elevation Model 900 = Other * – “xx” should be “01” when accuracy is certified to 1 meter or less.
501	12	Vertical-Accuracy (<i>Optional and Recommended</i>)	Maximum estimated error in vertical location Format: MMM.mm; 6 characters, indicating “plus or minus” a number of meters
502	13	Status	P = Proposed; A = Active; R = Retired

2.3.1.2 Description of FTRP Table Elements

Fields emboldened above are “key” fields – **Authority**, **FTRP-ID**, and **Date**; taken together, they make up a unique key for each record in the FTRP Table. They are required so that a record which describes a specific FTRP can be improved over time. Multiple authorities and data users will recognize, access, use, and archive FTRP records that represent a “real world” location, as identified by a particular authority at a particular point in time.

The required textual **Location-Description** must be sufficient to allow all users to unambiguously identify that FTRP in the field. However changes in applications and technology will allow the multiple authorities to refine over time the specifics of the Location-Description, coordinates, and accuracy Description. The use of a multi-part key provides relative permanence to the FTRP-ID, while allowing the creation of additional database records which can reflect these refinements. As a result, users will be able to embed FTRP within their own data structures, and acquire refined information about them over time (as it is made available by multiple authorities). At the same time they will not have to expend resources on updating internal references to this primary key.

The optional **FTRP-Feature-Type** allows the authority to provide information about the type of point feature designated as the FTRP. Each authority which chooses to use this field must reference the domain of valid attribute values in the NSDI Framework

Authority Index (See Section 2.8). The Authority-Information field of this record should contain a brief reference to the authority's use of the FTRP-Feature-Type, and should direct the user to the source of metadata about this attribute.

The **Latitude**, **Longitude**, and **Horizontal-Accuracy- Measurement-Method** of each FTRP must be provided. **Horizontal-Accuracy** is optional, but should be provided when the Authority believes accuracy to be +/- 1 meter (or better). When the **Elevation** is not blank, a valid **Vertical-Accuracy-Measurement-Method** code is also required.

Vertical-Accuracy is optional, but should be provided when the Authority believes accuracy to be +/- 1 meter (or better). The measurement method codes are intended to allow data users to assess the accuracy and precision of the FTRP position without requiring authorities to provide a quantitative error estimate.

A required **Status** code allows authorities to design and share/compare "proposed" FTRP with other interested authorities before coming to agreement on their designation. Also retention of records coded as "retired" enables users to update their databases after FTRP have been retired because of physical re-alignments or reconciliation of duplicate records.

2.3.2 Framework Transportation

Segment (FTSeg) – *A specified directed path between two Framework Transportation*

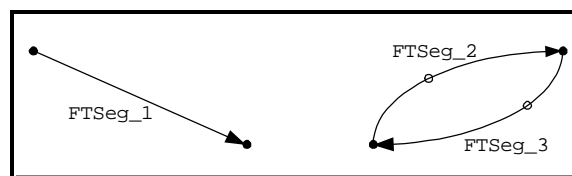


Figure 2 – Unique pathways connecting two FTRP

*Segment Reference Points along a physical transportation system that identifies
a unique segment of that system.*

FTSeg have no explicit geometry other than the locations of associated reference points (FTRP). Most FTSeg terminate at two FTRP. However, cul-de-sac loops may consist of FTSeg which originate and terminate at the same FTRP, and FTSeg may have other FTRP offset along their length. FTSeg should be depicted either by straight lines connecting two FTRP or by curved lines (if two or more FTSeg terminate at the same two FTRP.)³

2.3.2.1 Requirements for FTSeg

2.3.2.1.1 FTSeg must represent a component of the transportation network, with unambiguous beginning and end points (FTRP) that can be initially located and subsequently recovered in the field.

2.3.2.1.2 FTSeg must be independent of any particular cartographic display or analytical network. The nodes of a particular analytical network may be useful in defining the FTRP which begin and end at an FTSeg, but other points may serve as well.

³Guidelines for cartographic representation of FTRP and FTSeg are provided in Section 1.1 of Informative Appendix C.

2.3.2.1.3 An FTSeg may not cross the boundary of a State, territory or equivalent jurisdiction; therefore the maximum length of any FTSeg is the span of the jurisdiction in which it lies.

2.3.2.1.4 FTSeg must be stable over time. New links are routinely added, and existing links are routinely split in many transportation networks. New links may represent a newly constructed road, or they may represent a set of features (e.g., driveways) needed to support a particular application. In either case, existing FTSeg should not be changed in order to handle these additional links. In some rare instances it may be necessary and permissible to modify an existing FTSeg. The specific update procedures needed to handle such situations are detailed in Part 3 of this document.

2.3.2.2 The FTSeg Table

An FTSeg database record has a unique key consisting of fields 1, 2 and 3 (emboldened); all fields are required, unless otherwise indicated. An FTSeg record contains the following information:

#	FTSeg Table Field-Name	Description & Format/Domain
1	Authority-ID	Permanent and unique identifier of the organization which created the record. This ID may differ from the ID of the authority which created the original FTSeg database entry or subsequent records. Format specified in Section 2.6

572	2	FW-Transportation-Segment-ID	Permanent and unique identifier for the FTSeg Format specified in Section 2.6
573	3	Date	Date of creation of the record Form YYYYMMDD
574	4	From-End-Point	Unique identifier of the FTRP at which this FTSeg begins Format specified in Section 2.6
575	5	To-End-Point	Unique identifier of the FTRP at which this FTSeg ends Format specified in Section 2.6
576	6	Path-Description	Unambiguous description of the path of this FTSeg, which is unique with respect to any other FTSeg which connects the same two End-points. Free text: 255 characters or less
577	7	Intermediate-Point (<i>Required when Applicable</i>)	Identifier of the FTRP located at an intermediate point on the FTSeg for the purpose of distinguishing this FTSeg from (one or more) other FTSeg which share the same end points. Format specified in Section 2.6
578	8	FTSeg-Feature-Type (<i>Optional</i>)	Format: Free text of ten characters or less; Domain declared by the authority
579	9	State	Two-character code indicating the State, territory or equivalent entity within which the transportation segment begins and ends Codes are specified in FIPS 6-4
580	10	Length (<i>Optional and Recommended</i>)	Measured length of the segment Format: MMMMMM.mm; 9 character decimal meters

581	11	Length-Accuracy-Measurement-Method (<i>Required if Length is not "blank"</i>)	<p>Three-character code which describes the derivation of the Length measurement, and which allows the user to assess the accuracy and precision of the FTSeg length:</p> <p>100 = Survey measurement</p> <p>210 = Measured by a distance measurement device; e.g., "fifth wheel"</p> <p>220 = Measured by an automobile odometer or analogous device</p> <p>310 = Computed from a digital vector database scaled at larger than 1:12000</p> <p>320 = Computed from a digital vector database scaled at from 1:12000 to 1:100,000</p> <p>330 = Computed from a digital vector database scaled at smaller than 100,000</p> <p>900 = Other</p>
582	12	Status	P = Proposed; A = Active; R = Retired

2.3.2.3 Description of FTSeg Table Element

Fields emboldened above are "key" fields – **Authority**, **FTRP-ID**, and **Date**; taken together, they make up a unique key for each record in the FTSeg Table. These fields are required in order that FTSeg records can be improved by multiple authorities over time, archived, and accessed by different users, just as FTRP records can be. The **From-End-Point** and **To-End-Point** values are required in order to unambiguously delineate each FTSeg. (Refer to description **Intermediate-Point**, below.)

An FTSeg record must include an **Intermediate-Point** consisting of a single FTRP-ID whenever the FTSeg in question has the same From-End-Point and To-End-Point as one

592 or more other FTSeg. The additional FTRP identified in this field should represent an
593 intermediate point along the FTSeg, judiciously selected in order to assure that the
594 multiple FTSeg which terminate at the same FTRP are unambiguously differentiated.
595 Pairs of FTSeg for which the To-End-Point and From-End-Point are reversed will occur
596 routinely; they must be assigned different unique FTSeg identifiers, but need not have
597 Intermediate-Points.

598 A textual **Path-Description** that is sufficiently complete as to allow other users to
599 unambiguously identify the course of the FTSeg in the field is also required.

600 The optional **FTSeg-Feature-Type** allows the authority to provide information about the
601 type of linear feature designated as the FTSeg. Each authority which chooses to use this
602 field must reference the domain of valid attribute values in the NSDI Framework
603 Authority Index (See Section 2.8). The Authority-Information field of this record should
604 contain a brief reference to the authority's use of the FTSeg-Feature-Type, and should
605 direct the user to the source of metadata about this attribute.

606 A required **State** code allows authorities and users to more easily identify records of
607 possible interest. Because FTSeg may not cross state boundaries, in most cases the code
608 should indicate the State, territory or equivalent entity within which the transportation
609 segment begins and ends. If the FTSeg lies precisely along a boundary line between two

States, territories or equivalent entities, these entities should derive a shared business rule for coding the FTSeg.

Length and **Length-Accuracy-Measurement-Method** are optional. The accuracy description codes are intended to allow data users to assess the precision of the FTSeg length without requiring authorities to provide a quantitative error estimate.

A required **Status** code allows authorities to design and share/compare “proposed” FTSeg with other interested authorities before coming to agreement on their designation. Also

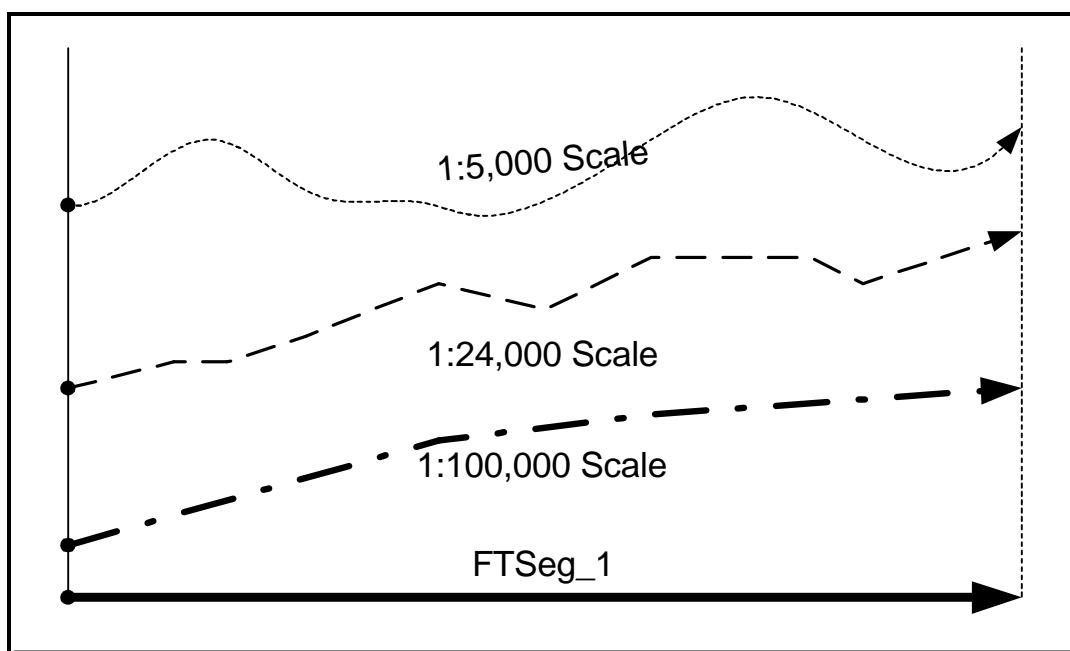


Figure 3 - Representation of an FTSeg and different scales

retention of records coded as “retired” enables users to update their databases after FTSeg have been retired because of physical re-alignments or reconciliation of duplicate records.

While FTSeg have no explicit geometry themselves, they may be represented by a variety of cartographic line segments depicting their shape and location on the earth. The line segments may be more or less complex, reflecting different scales of resolution, map projections, or structural detail.

2.4 Connectivity of Framework Transportation Segments

FTSeg may be used to construct topological networks, but do not represent a topological network by themselves. FTRP are required to establish connections among two or more FTSeg, either at their termini and/or at some offset along their length. FTRP can optionally be placed along FTSeg in locations at which no connectivity occurs. The structure in which these relationships are established is described below.

2.4.1 The Connectivity Table

All topological relationships between entities in the data standard are described in the Connectivity Table. At least one record must exist for each FTSeg. At least one record must exist for each FTRP, even if it occurs at the terminus of an FTSeg or at some other location at which no connectivity exists; e.g., a bridge or a railroad crossing. More than one record will exist for each FTRP at which connectivity occurs. The Connectivity Table

supports a “one-to-many” relationship between FTRP and the number of connections made at each, so is in the form of an unordered list:

#	Connectivity Table Field Name	Description & Format/Domain
1	Authority-ID	Permanent identifier of the organization which created this record. This ID may differ from the ID of the authority which created the original FTRP database entry or subsequent records. Format specified in Section 2.6
2	FW-Transportation-Segment-Reference-Point-ID	Permanent and unique identifier for the FTRP Format specified in Section 2.6
3	Date	Date of creation of this record Format YYYYMMDD
4	FTSeg-ID	Unique identifier of an FTSeg along which this FTRP falls. Format specified in Section 2.6
5	FTSeg-Offset-%	Percentage offset from the FTSeg From-End-Point at which this FTRP falls A positive decimal number greater than or equal to “0” and less than or equal to “100.0000”. Format: 000.0000; 8 characters

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6	Offset-%-Accuracy-Description	<p>Three-character code which describes the derivation of the FTSeg-Offset-% measurement, and which allows the user to assess the accuracy and precision of the offset along the FTSeg:</p> <p>100 = Survey measurement</p> <p>210 = Measured by a distance measurement device; e.g., “fifth wheel”</p> <p>220 = Measured by an automobile odometer or analogous device</p> <p>310 = Computed from a digital vector database scaled at larger than 1:12000</p> <p>320 = Computed from a digital vector database scaled at from 1:12000 to 1:100,000</p> <p>330 = Computed from a digital vector database scaled at smaller than 100,000</p> <p>900 = Other</p>
7	Status	P = Proposed; A = Active; R = Retired

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2.4.2 Description of Connectivity Table Elements

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FTRP-ID, **Authority**, and **Date** are required so that each record indicates what authority established the placement of an FTRP along an FTSeg, and when.

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An **FTSeg-ID** indicates the segment along which the FTRP lies. The **FTSeg-Offset-%**

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indicates the FTRP’s placement along the FTSeg, and the **Offset-%-Accuracy-**

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Description codes are intended to allow data users to assess the precision of the FTSeg-

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Offset-% without requiring authorities to provide a quantitative error estimate.

A required **Status** code allows authorities to design and share/compare “proposed” FTRP with other interested authorities before coming to agreement on their designation. Also retention of records coded as “retired” enables users to update their databases after FTRP have been retired because of physical re-alignments or reconciliation of duplicate records.

2.4.3 Categories of Connectivity⁴

2.4.3.1 Two or more FTSeg are said to be *terminally* connected if they share a common FTRP at their termini.

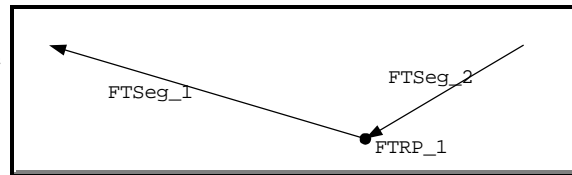


Figure 4 – Terminal connectivity of two FTSeg at FTRP_1

The terminal connectivity illustrated in Figure 4 is implemented in the Connectivity Table in two records for FTRP_1; one indicates that FTRP_1 is offset 0% of the length of FTSeg_1. The second record indicates that FTRP_1 is offset 100% of the length of FTSeg_2. The FTSeg-Offset-% in such records will always be “0%” or “100%.” The Table would contain one record for any additional FTSeg which was terminally connected at FTRP_1 .

⁴Previous drafts of the Standard defined two connectivity types; this version introduces a third connectivity type. The definition of *explicit connectivity* is the same as in previous drafts. The definition of *implicit connectivity* has changed from that used in previous drafts, and the definition used formerly applies in this draft to *terminal connectivity*.

2.4.3.2 Segments are said to be *explicitly* connected whenever:

2.4.3.2.1 there are two or more records in the Connectivity Table which describe the same FTRP, and

2.4.3.2.2 at least one of the records indicates that the FTRP falls at a termini of an FTSeg, and

2.4.3.2.3 at least one other record indicates that the FTRP lies on an FTSeg at a point other than a terminus.

In Figure 5, P3 is an end point of FTSeg_2 and P4 is an end point of FTSeg_3 and FTSeg_4.

All of these segments are connected *explicitly* to FTSeg_1, which is the entire line segment

terminating at P1 and P2. The values entered in the important fields of the Connectivity Table are as follows:

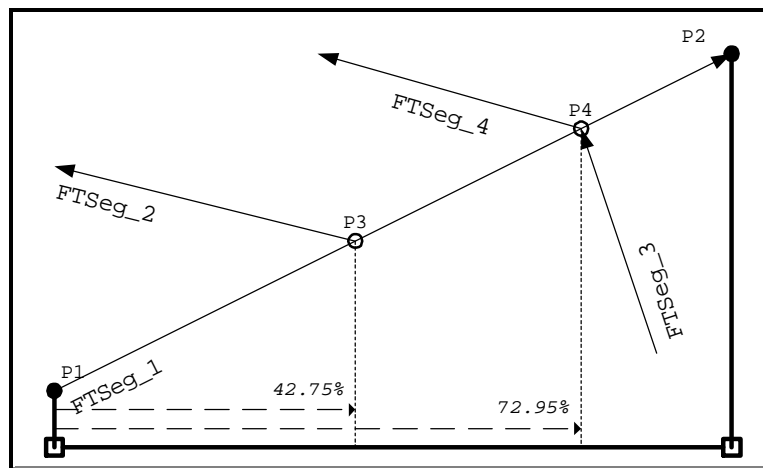


Figure 5 - FTSeg_2, FTSeg_3, and FTSeg_4 are connected explicitly to FTSeg_1

Field #2- FTRP-ID	Fields #1, #3, #6, #7	Field #4- FTSeg-ID	Field #5- FTSeg- Offset-%
P3	Other Data	FTSeg_2	0.00%
P3	"	FTSeg_1	42.75%
P4	"	FTSeg_3	100.00%
P4	"	FTSeg_4	0.00%
P4	"	FTSeg_1	72.95%

2.4.3.3 Two or more FTSeg are said to be *implicitly* connected when there are two or more records in the Connectivity Table which describe the same FTRP, and all of these records indicate that the FTRP lies on the (multiple) FTSeg at a point other than a terminus of the FTSeg. The implicit connectivity illustrated in Figure 5 is implemented in the Connectivity Table in two records for FTRP_1, each indicating that it is offset a specific percentage of the length of FTSeg_1 and FTSeg_2. The Table would contain one record for any additional FTSeg which passed through or which terminated at FTRP_1 .

2.4.4 Conditions lacking Connectivity

2.4.4.1 An FTRP which does not connect multiple FTSeg may be offset along the length of an FTSeg in order to establish the distinction

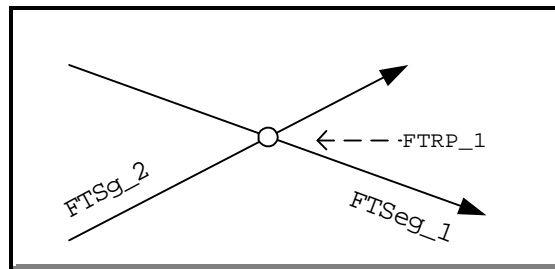


Figure 6 - Implicit connectivity of FTSeg_1 and FTSeg_2

among two or more segments which terminate at the same two endpoints. Such an FTRP is recorded as the Intermediate-Point of the FTSeg record to establish uniqueness, and should be recorded in the Connectivity Table.

2.4.4.2 An unconnected FTRP may be offset along the length of an FTSeg to mark its intersection with an important but unconnected linear feature (jurisdiction boundary, railroad or water bridge), and should be recorded in the Connectivity Table.

2.4.4.3 The topological properties of FTSeg consist exclusively of the connectivity derived from a shared FTRP. Therefore FTSeg_1 and

FTSeg_2 may cross without the need for an FTRP at the

crossover, as in Figure 7. There is no connectivity between the transportation segments illustrated in this figure; no topological connection exists for FTSeg_1 and FTSeg_2 unless an FTRP is defined in order to provide for a topological connection.

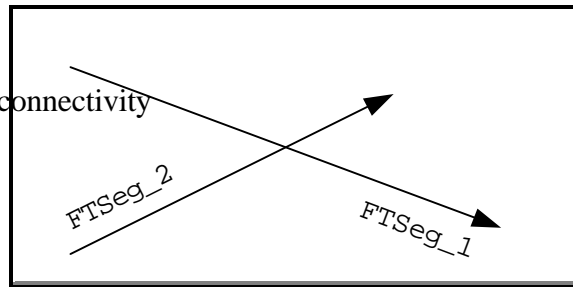


Figure 7 - Intersecting but unconnected FTSeg

2.4.4.4 Two unconnected FTRP may share the same horizontal coordinates, though not the same elevation. In such circumstances there is no implication either that

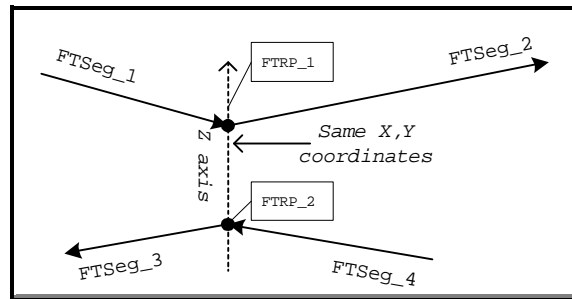


Figure 8 - Unconnected sets of FTSeg

the two FTRP are identical, or that the two sets of FTSeg are connected. Figure 8 shows that FTSeg_1 and FTSeg_2 are connected terminally at FTRP1, and that FTSeg_3 and FTSeg_4 are connected terminally at FTRP2. FTRP1 and FTRP2 share the same (X-Y) coordinates but have different elevations, so there is no connectivity between the two sets of FTSeg.

Using terminal, implicit, and explicit connectivity encoded in the Connectivity Table, selected subsets of FTSeg may be combined to create custom networks. The only requirement for the derivation of such networks is that any FTSeg included in the network must connect with another FTSeg that is also part of the network.

2.5 Relating Attributes of Transportation Segments to FTRP and FTSeg

Organizations that wish to share information about different transportation databases will have an interest in identifying those “real world” feature attributes (e.g. functional class, name or route number, and street address ranges) of value within their applications. The

identification of such attributes, definition of their domains or formats is not a part of this Standard. This and other information about these attributes will be defined by national standards and practices, or by the users of the data for a particular geography.

Often the values of defined attributes of linear features will not relate to 100% of the length of a particular FTSeg. These attributes -- in addition to attributes pertaining to an FTRP or a complete FTSeg – can be shared by means of an Attribute Table that relates the particular attribute values to one or more FTRP or FTSeg. The Attribute Table supports a “many-to-many” relationship between FTRP and FTSeg objects, and the attributes associated with each, so is in the form of an unordered list:

#	Attribute Table Field-Name	Description & Format/Domain
1	Authority-ID	Permanent and unique identifier of the authority which generates or distributes the attribute. Format specified in Section 2.8
2	FW-Transportation-Segment-ID-or-Reference-Point-ID	Permanent and unique identifier for the FTSeg or FTRP with which an attribute is associated Format specified in Section 2.6
3	Date	Date of creation of the attribute record Format YYYYMMDD

752	4	Start-Offset	For FTRP attributes: "000.0000" For FTSeg attributes: Percentage offset from the FTSeg From-End-Point at which this attribute value commences A positive decimal number greater than or equal to "0" and less than or equal to "100.0000" with format: +000.0000
753	5	End-Offset	For FTRP attributes: "000.0000" For FTSeg attributes: Percentage offset from the FTSeg From-End-Point at which this attribute value ends A positive decimal number greater than or equal to "0" and less than or equal to "100.0000" with format: +000.0000
754	6	Attribute-Name	Free text: 64 characters or less
755	7	Attribute-Value	Attribute value

Values are required for all fields. Descriptions of **Authority-ID**, **FTSeg-or-FTRP-ID**, **Date**, and **Offsets** can be found in the discussion of the FTSeg Table earlier in section 2.3.2.2. **Attribute-Name** and **Attribute-Value** are fields which should contain the name applied by the Authority to a specific attribute, as well as the value of that attribute. Attribute values conveyed in table records apply to the FTRP or FTSeg (or portion thereof) identified in the particular record. Information about different named attributes (e.g., "Route-#" and "Road-Name") must be conveyed in separate records pertaining to each FTRP or FTSeg (or portion thereof). Metadata about each named attribute – including the description, format and domain – should accompany the Attribute Table, and

should conform to the FGDC Content Standard for Digital Geospatial Metadata (version 2.0).

2.6 Unique Identifiers of FTRP and FTSeg

Each FTRP and FTSeg has a unique and permanent identification code of fixed length in the following format:

AAAAA.O.XXXXXXXXXX

2.6.1 Authority-ID

AAAAA – Each FTRP and FTSeg identifier includes the unique identifier of an Framework Transportation Data Authority. This code identifies the organization which generated the first database entry, or “originating” record describing the FTRP or FTSeg. An Authority-ID also occurs in a separate data base field in each FTRP and FTSeg record. This field records the identity of an authority which improves database records about FTRP or FTSeg subsequent to the creation of the unique FTRP or FTSeg identifiers. (Specifications for creating identifiers for each authority are the topic of a following section.).

2.6.2 Object Type

781 **O** – Each FTRP identifier includes a “P” and each FTSeg includes an “S.”

782 2.6.3 Identity-Code

783 **XXXXXXXXXX** is a zero-filled, right-justified, alpha-numeric identifier of nine characters
784 in length for each FTRP or FTSeg. Authorities can use different methods for designating
785 unique values for the Identity Code; assignment of sequential integers, or use of segment
786 codes already in use are acceptable methods. Such codes, once assigned, are part of the
787 permanent identifier of each FTRP and FTSeg, and do not change if the pre-existing
788 codes change in a particular user database or application.

789 2.7 Relating Equivalent Representations of FTRP and FTSeg

790 2.7.1 Equivalent FTRP and FTSeg

791 At points of connectivity between differing representations of the traveled way(s) all
792 FTSeg must be capable of connecting to other FTSeg. And wherever authorities maintain
793 databases describing different representations of equivalent features FTRP and FTSeg
794 must be related so they can support exchange of attributes across these databases.

2.7.1.1 Many authorities will maintain databases in which two or more traveled ways separated by a physical barrier are represented by two or more sets of line segments, which can be represented as separate segments.

2.7.1.2 Other data authorities may maintain databases in which parallel traveled ways separated by a physical barrier are represented by a single set of line segments; e.g. a small-scale representation of an Interstate highway.

2.7.1.3 Still other authorities may maintain databases in which the same roadway is represented with “complex” features such as lanes, access roads, and entrance/exit ramps. “Complex” FTRP or FTSeg represent multiple discrete physical points or segments included within the same undivided travelway, over any of which vehicles can pass while remaining within that traveled way.

2.7.2 The FTSeg and FTRP Equivalency Table

Equivalence among multiple representations of FTRP and FTSeg can be sustained by the creation and maintenance of Equivalency Table data records that establish analogous relationships between two or more FTRP, or between one FTSeg and another FTSeg (or portion thereof.) One FTRP (or FTSeg) may have 0 or 1 or more FTRP (or FTSeg) which are equivalent, but which make up a different representation. Since one FTSeg also may be equivalent to a fraction of another FTSeg, the Table supports “many-to-many” relationships, and is in the form of an unordered list:

#	Equivalency Table Field-Name	Description & Format/Domain
1	Reference-FTRP-ID or Reference-FTSeg-ID	Permanent and unique identifier for the FTRP or FTSeg Format specified in Section 2.6
2	Equivalent_FTRP_ID or Equivalent_FTSeg_ID	Permanent and unique identifier for the FTRP or FTSeg which is equivalent Format specified in Section 2.6
3	Date	Date of creation of the record Format YYYYMMDD
4	Start-Offset (<i>required if the entity named in Fields 1 & 2 is an FTSeg</i>)	For FTSeg records only: Percentage offset from the From-End-Point of the FTSeg identified in the Reference-FTSeg-ID at which equivalency commences A positive decimal number greater than or equal to "0" and less than or equal to "100.0000" with format: +000.0000
5	End-Offset (<i>required if the entity named in Fields 1 & 2 is an FTSeg</i>)	For FTSeg records only : Percentage offset from the From-End-Point of the FTSeg identified in the Reference-FTSeg-ID at which this equivalency ends A positive decimal number greater than or equal to "0" and less than or equal to "100.0000" with format: +000.0000
6	Status	P = Proposed; A = Active; R = Retired

The **Reference-FTRP-ID** or **Reference-FTSeg-ID** and **Equivalent_FTRP_ID** or **Equivalent_FTSeg_ID** are the IDs of entities which have been created in the FTSeg Table or the FTRP Table, and which are equivalent (wholly or in part). The **Start-Offset** and **End-Offset** are percentage numbers used to identify the portion of two different

FTSeg which are equivalent (wholly or in part). Authorities must indicate equivalency by making entries in this Table whenever they create:

2.7.2.1 a new representation of a point or segment which is equivalent to one or more other representations of the same point or segment identified by already-existing FTRP or FTSeg,); or

2.7.2.2 a representation of a (new) FTSeg that is equivalent to a fraction of another FTSeg representation.

2.7.3 Relating Equivalent FTRP and FTSeg

Each FTRP and FTSeg which represents a portion of a transportation network is assigned a unique Identity Code which is a permanent nine-character identifier. Each authority creates or uses an FTRP-ID or FTSeg-ID to identify segments and points in one (or more) specific database(s), and makes entries in the Equivalency Table when these segments and points represent the same physical features represented in other databases using other FTRP-IDs or FTSeg-IDs.

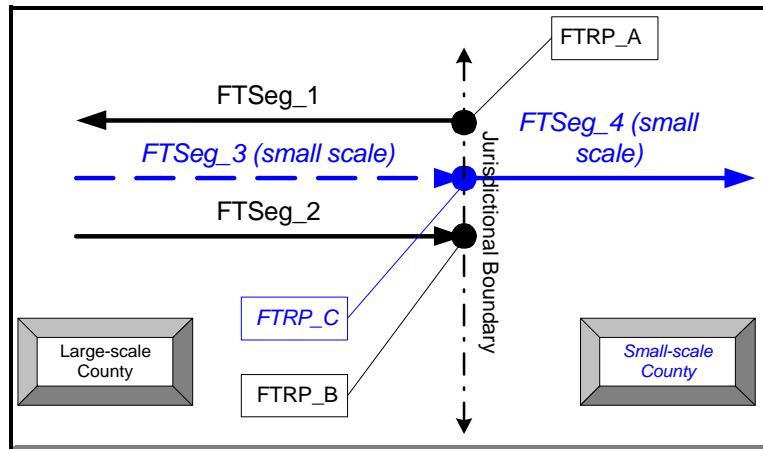


Figure 9 - Equivalency between “Single line” and “Dual line” representations of a Divided Roadway

In Figure 9, an authority has created a more-detailed representation of the divided highway to the left of the boundary; segments are identified as FTSeg_1 and FTSeg_2. For another less-detailed representation of the same segments an authority has used FTSeg-ID numbers FTSeg_3, and has connected it to FTSeg_4. The authority should make entries in the Equivalency Table to indicate that FTSeg_1, FTSeg_2, and FTSeg_3 are all representations of the same feature(s). (Similar entries should be made to indicate that the three FTRP are equivalent.) Use of the Equivalency Table supports establishment of equivalency between any number of representations of equivalent points (FTRP), and any number of representations of equivalent segments or partial segments (FTSeg) on a “one to many” or “many to one” basis. The entries which should be made in the important fields of the Equivalency Table in order to represent the equivalent entities illustrated in Figure 9 are as follows:

Field #1- Reference- ID	Field #2 - Equiva- lent-ID	Field #4- Start- Offset	Field #5- End-- Offset
-------------------------------	----------------------------------	-------------------------------	------------------------------

FTSeg_1	FTSeg_3	0.00%	100.00%
FTSeg_2	FTSeg_3	100.00%	0.00%
FTRP_A	FTRP_C	0.00%	0.00%
FTRP_B	FTRP_C	0.00%	0.00%

2.8 Framework Transportation Data Authorities

An NSDI Framework Transportation Data Authority may perform some or all of the functions necessary to build and operate the NSDI Framework. These functions are: *Data Development, Maintenance, and Integration, Data Access, Data Management, Coordination, Executive Guidance, Resource Management, and Monitoring and Response*. For further information, see the “NSDI Framework Introduction and Guide,” FGDC, 1997, Chapter 4.

2.8.1 Definition of an Authority

Any organization which takes responsibility for proposing, designating, or working in partnership with other organizations to define FTRP and FTSeg is -- for the purposes of this standard -- operating as an “authority.” Organizations which act as authorities:

2.8.1.1 create or update transportation databases (or plan to do so), and

2.8.1.2 share those databases or related attribute sets with others (or plan to do so), and

2.8.1.3 conform database development and maintenance activities to this standard.

2.8.2 Unique Identifiers for Authorities

Each authority is identified by a permanent, unique, fixed-length code of five characters in the form of **AAAAA**. Organizations which perform authority functions in one state or any part of one state will assume a unique identifier, the first two characters of which consist of the state or territory code specified in FIPS 6-4. The following three characters consist of a unique code for each authority located within the state. The code should be made up of three numeric characters. *EXAMPLE: The Vermont Agency of Transportation could assume an Authority-ID of "50001," the Vermont Enhanced-911 Board could assume the Authority-ID of "50002," with other state-specific state, regional and local agencies assuming other identifiers.*

Federal agencies, organizations which produce data for multiple states, and non-domestic authorities can all be accommodated by using the code of "00" in the first two characters. The remaining three characters consist of a code unique to each authority, as described in the previous section. Multi-state authorities which have multiple database maintenance operations or separate geographic units can assume separate Authority-IDs. *EXAMPLE: Some federal agencies which are FGDC members perform data development and maintenance in facilities in multiple regions of the US. Such regional data maintenance*

895 *facilities may choose to become authorities, and each should use a unique code*

896 *beginning with "00."*

897 2.8.3 Descriptive Attributes for each Authority

898 Information about each authority is maintained in an NSDI Framework Authority Index;

899 (See Part 3 - Implementation Procedures). The information content relating to each

900 authority is based on the "Contact-Information" content specified within the FGDC

901 "Content Standard for Digital Geospatial Metadata." It includes the following

902 information:

#	Authority Field-Name	Description & Format/Domain
1	Authority-ID	Permanent and unique identifier of the organization. Five character numeric code: see Section 2.8.1 and 2.8.2
2	Date	Date of creation of the record Format YYYYMMDD
3	Authority-Name	Name of the organization acting as an authority Free text: 255 characters or less
4	Contact-Person-Primary	Name of a contact person Free text: 255 characters or less
5	Contact-Voice-Telephone	Voice telephone number of Contact-Person-Primary Free text: 20 characters

909	6	Contact-Facsimile-Telephone (<i>optional</i>)	Fax telephone number of Contact-Person-Primary Free text: 20 characters
910	7	Contact-Electronic-Mail - Address (<i>optional</i>)	E-mail address of Contact-Person-Primary Free text: 64 characters or less
911	8	Contact-URL (<i>optional</i>)	Universal Resource Locator for Internet access to the Authority Free text: 64 characters or less
912	9	Contact-Instructions	Instructions for contacting the Authority Free text: 255 characters or less
913	10	Authority-Address	Mail delivery address of the Authority Free text: 255 characters or less
914	11	Authority-City	Mail delivery city of the Authority Free text: 255 characters or less
915	12	Authority-State-or-Province	Mail delivery state (US) or province (non-US) of the Authority Free text: 64 characters or less
916	13	Authority-Postal-Code	Mail delivery ZIP (US) or postal code of the Authority Free text: 20 characters or less
917	14	Authority-Country	Mail delivery Country of the Authority Free text: 64 characters or less
918	15	Authority-Index-Access- Information	Information informing potential users of the Authority's data how to obtain access to or a copy of the index containing the relevant FTRP and FTSeg information. Link(s) to the standardized metadata describing the database(s) should be included. Free text: 255 characters or less

919

16

Authority-Information
(*optional*)Additional information about the geographic
area, types of transportation activities, or data
maintenance operations in which the Authority
is engaged

Free text: 255 characters or less

920

17

Status

P = Proposed; **A** = Active; **R** = Retired